

## Factors affecting patient valuations of caries prevention

Vernazza, Christopher R.; Wildman, J.R.; Steele, John G.; Whitworth, John M.; Walls, Angus W.G.; Perry, Ross; Matthews, Roger; Hahn, Petra; Donaldson, C.

*Published in:*  
Journal of Dentistry

*DOI:*  
[10.1016/j.jdent.2015.05.009](https://doi.org/10.1016/j.jdent.2015.05.009)

*Publication date:*  
2015

*Document Version*  
Author accepted manuscript

[Link to publication in ResearchOnline](#)

### *Citation for published version (Harvard):*

Vernazza, CR, Wildman, JR, Steele, JG, Whitworth, JM, Walls, AWG, Perry, R, Matthews, R, Hahn, P & Donaldson, C 2015, 'Factors affecting patient valuations of caries prevention: using and validating the willingness to pay method', *Journal of Dentistry*, vol. 43, no. 8, pp. 981-988.  
<https://doi.org/10.1016/j.jdent.2015.05.009>

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**Title:** Factors affecting patient valuations of caries prevention: using and validating the willingness to pay method

**Short title:** Patient valuations of caries prevention

**Authors:** Christopher R. Vernazza<sup>a,b</sup>, John R. Wildman<sup>b,c</sup>, Jimmy G. Steele<sup>a,b</sup>, John M. Whitworth<sup>a,b</sup>, Angus W.G. Walls<sup>d</sup>, Ross Perry<sup>e</sup>, Roger Matthews<sup>f</sup>, Petra Hahn<sup>g</sup>, Cam Donaldson<sup>h</sup>

*a Centre for Oral Health Research and School of Dental Sciences, Newcastle University, Framlington Place, Newcastle upon Tyne. NE2 4BW. UK.*

*b Institute of Health and Society, Newcastle University, The Baddiley-Clark Building, Richardson Road, Newcastle upon Tyne. NE2 4AX. UK.*

*c Newcastle University Business School, 5 Barrack Road, Newcastle upon Tyne. NE1 4SE. UK.*

*d Edinburgh Dental Institute, 4th Floor, Lauriston Building, Lauriston Place, Edinburgh. EH3 9HA. UK.*

*e CHX Technologies Inc., 4800 Dundas Street West, Suite 105, Toronto, Ontario. M9A 1B1. Canada.*

*f Denplan Ltd., Denplan Court, Victoria Road, Winchester, Hampshire. SO23 7RG. UK*

*g University Medical Center Freiburg, Dental School and Hospital, Department of Operative Dentistry and Periodontology, 79104 Freiburg, Hugstetter Strasse 55.*

*h Yunus Centre for Social Business & Health, Institutes for Applied Health Research and Society & Social Justice Research, Glasgow Caledonian University, 3rd Floor, Buchanan House, Cowcaddens Road, Glasgow. G4 0BA. UK*

**Email addresses:**

[c.r.vernazza@ncl.ac.uk](mailto:c.r.vernazza@ncl.ac.uk)

[john.wildman@ncl.ac.uk](mailto:john.wildman@ncl.ac.uk)

[jimmy.steele@ncl.ac.uk](mailto:jimmy.steele@ncl.ac.uk)

[john.whitworth@ncl.ac.uk](mailto:john.whitworth@ncl.ac.uk)

[Angus.Walls@ed.ac.uk](mailto:Angus.Walls@ed.ac.uk)

[rossperry@chxtechnologies.com](mailto:rossperry@chxtechnologies.com)

[RogerM@denplan.co.uk](mailto:RogerM@denplan.co.uk)

[petra.hahn@uniklinik-freiburg.de](mailto:petra.hahn@uniklinik-freiburg.de)

[Cam.Donaldson@gcu.ac.uk](mailto:Cam.Donaldson@gcu.ac.uk)

**Corresponding author:**

Christopher R. Vernazza Centre for Oral Health Research and School of Dental Sciences, Newcastle University, Framlington Place, Newcastle upon Tyne. NE2 4BW. UK.

Email: [c.r.vernazza@ncl.ac.uk](mailto:c.r.vernazza@ncl.ac.uk) Telephone +44 (0) 191 2088396

**Abstract**

## ***Objectives***

Determining the value of, or strength of preference for health care interventions is useful for policy makers in planning health care services. Willingness to pay (WTP) is an established economic technique to determine the strength of preferences for interventions by eliciting monetary valuations from individuals in hypothetical situations. The objective of this study was to elicit WTP values for a dental preventive intervention and to analyse the factors affecting these as well as investigating the validity of the WTP method.

## ***Methods***

Patients aged 40 years plus attending dental practices in the UK and Germany were recruited on a consecutive basis over one month. Participants received information about a novel root caries prevention intervention. They then completed a questionnaire including a WTP task. Where the coating was indicated, patients were offered this for a payment and acceptance was recorded. Analysis included econometric modelling and comparison of expected (based on stated WTP) versus actual behaviour.

## ***Results***

The mean WTP for the coating was £96.41 (standard deviation 60.61). Econometric models showed that no demographic or dental history factors were significant predictors of WTP. 63% of the sample behaved as expected when using stated WTP to predict whether they would buy the coating. The remainder were split almost equally between those expected to pay but who didn't and those who were expected to refuse but paid.

## ***Conclusions***

Values for a caries preventive intervention had a large and unpredictable variance. In comparing hypothetical versus real preferences both under- and over-valuation occurs.

## ***Clinical Significance***

Wide and unpredictable variation in valuations for prevention may mean that there are difficult policy questions around what resource should be allocated to dental prevention and how to target this resource.

**Keywords**

Preference-based measures, willingness to pay, caries, prevention

## Introduction

Difficult decisions will always need to be taken about allocating the resources available in any dental service. One important input into the decision making process is the value patients and the public (in publicly funded systems) place on the services being considered.

Economics has specific ways of measuring valuations and one technique, willingness to pay (WTP) has particular advantages for valuing dental interventions.<sup>1,2</sup> Studying an area where patients already pay (as is common in dentistry) also allows the investigation of actual behaviour compared to hypothetical, stated WTP values, important for the development of WTP methods themselves.

One example of a difficult resource allocation decision would be the question of how much to invest in prevention versus treatment. Moving from treatment to prevention of oral disease has been recognised worldwide as an important aim for any dental healthcare system.<sup>3</sup>

Increasing uptake and provision of prevention is a complex task as this relies on both professional and patient behaviour change. Influencing factors for any health behaviour change may include incentives for both clinicians and patients (usually through the healthcare system) as well as barriers to change.<sup>4</sup> Policy makers and service managers must also be convinced of the need and benefits in order to commit resources and design healthcare systems with favourable incentives.

Understanding patient values of prevention and factors influencing these would allow the development of strategies to change patient behaviour and may also influence the design of healthcare systems. Values elicited in a systematic and robust manner using established techniques from the discipline of economics can be incorporated into frameworks which facilitate policy makers in making resource allocation decisions.

In economics, values are based on the concept of utility, where utility theory states that when making a choice in the presence of uncertainty, which characterises many health decisions, individuals should choose the option that maximises their expected benefit or personal satisfaction. One approach (albeit not the most common in health) to eliciting utility is to determine a monetary valuation. The most accepted monetary valuation technique is

willingness to pay (WTP)<sup>5</sup>, where the respondent is presented with a hypothetical scenario in which a health care intervention or health state is to be valued and asked the maximum they would be willing to pay for the intervention or to improve their health state. WTP has been suggested as the most appropriate preference based measure in dentistry.<sup>1, 2</sup> However, in dentistry, little work has been done looking at patient preferences and only a very limited number of studies have been reported applying WTP.<sup>6</sup>

Although the arguments for WTP outweigh the problems of other health state utility measures,<sup>2, 7</sup> there are some criticisms of WTP. The principal problem raised is its link with ability to pay i.e. those who are able to pay more have a greater influence on WTP and so have a greater influence on decisions. However, methods have been developed to account for this.<sup>8</sup>

A further criticism is that, as the exercise is hypothetical, then stated WTP may overestimate true WTP.<sup>9</sup> There have been extensive experiments in artificial (“laboratory”) settings and in field settings in environmental economics where stated preference (i.e. WTP) is compared with revealed preference (i.e. actual spending of money) which generally support the hypothesis that stated preference overestimates revealed preference.<sup>10</sup> In health, two experiments have addressed revealed versus stated preference with mixed results.<sup>11, 12</sup> Dentistry, often requiring some form of direct payment from the patient, is one of the areas of health where revealed preference can be easily observed and this study gives an opportunity to investigate revealed preference as well as stated preference.

The aim of this study was therefore to elicit values for a dental preventive intervention and to analyse the factors affecting these. Secondly, the validity of the WTP method was investigated by comparing WTP values with revealed preference.

## **Methods**

### ***Context and setting***

The context used in this study was dental care provided in the UK and Germany. In the UK, dentistry is offered both under a state system (NHS) and privately. The private provision is

offered in several formats including out-of-pocket payments, based on fee per item scales or on time charges, insurance based schemes or capitation schemes where patients pay a regular fee to cover all treatment provided. In this study, UK participants were recruited from five primary care dental practices in the North East of England UK which all offered a variety of payment methods to patients.

In Germany, the vast majority of dental treatment is paid for on an insurance basis, either through state organized schemes (Bewertungsmaßstab zahnärztlicher Leistungen, BEMA ) or through private insurance schemes (Gebührenordnung für Zahnärzte, GOZ). At the time of the study the BEMA scheme consisted of insurance payments being 50% employer funded and 50% self-funded with all dental care aside from some advanced treatments fully covered, with the exception of a €10 surcharge payable in each quarter in which there had been at least one dental visit. The private schemes varied in cover comprehensiveness, with patients choosing their own level of cover from a variety of providers. The four German dental practices, located in Freiburg, in South West Germany, all operated in this mixed market. No major differences in behaviour between the two countries were anticipated but the split sample allowed this to be investigated.

### ***The Intervention***

The intervention used as an exemplar in this study was a novel coating (Prevora, CHX Technologies) applied topically to teeth to reduce the risk of caries, in particular root caries. At the time of the study, the evidence relating to the effectiveness of the treatment showed that the reduction in root caries increment over 1 year was 41%.<sup>13</sup> The coating contains 10% chlorhexidine and is applied by a dental professional to all the teeth of patients who are at risk of dental caries<sup>14</sup> under a resin-based sealant. Although chlorhexidine has been used previously in caries prevention, at the time of the study, this intervention was novel both in its concentration (10%) and because the intervention was a combination of both a varnish and a resin based sealant used to hold the chlorhexidine in place. The treatment regimen consists of 4 treatments at weekly intervals in the first month, followed by a single reapplication every 6 months until the patient is no longer at risk of caries. The introduction of this new product to

the dental market allowed the opportunity to elicit and study patient values for a preventive product.

### ***Sample***

The patients included all those paying by any method in Germany and in the UK both private fee per item (out of pocket) payers and members of a limited capitation scheme (Denplan Essentials) where patients pay a monthly fee which covers assessments, radiographs and basic periodontal care, but where participants pay for all other items out of pocket.

Inclusion criteria for the questionnaire arm of the study was that the patient was using the payment methods detailed and was aged over 40 (as the intervention was licensed for root caries prevention; rare in under 40 year olds). For the follow on treatment arm, inclusion criteria included having completed the questionnaire arm and being at risk of root caries (determined as those who had experienced caries in the previous 2 years and also had one of the following: gingival recession of 1mm or greater; limited salivary flow; multiple medication use; active periodontal disease; removable partial denture wearer). Those with allergy to components of the intervention were excluded. Only the group who were eligible for and participated in both the questionnaire arm and treatment arm of the study could be included in the comparison of revealed versus stated preference. The sample was recruited on a consecutive basis over a 4 week period at each practice with all practices recruiting in either 2008 or 2009. All patients meeting the inclusion and exclusion criteria attending the practices during these weeks were asked to participate. The sampling is illustrated as part of the patient pathway through the study in Figure 1.

### ***Questionnaire design***

Printed information including details about the product and its effectiveness (in terms of an estimate in the reduction of risk of needing a restoration based on best evidence available at the time of the study) was given to patients prior to completion of the questionnaire. It was made clear in the questionnaire that the varnish would not be included in any dental insurance arrangement that the patient currently had. The self-completion questionnaire then contained several basic demographic questions based on best practice guidelines<sup>15</sup> followed by several



questions concerning previous dental experience and knowledge. A WTP instrument using a bidding card method to elicit values was then introduced (available on request from the authors). The questionnaires were piloted and minor changes to wording and layout were made. Finally, the questionnaires were translated and reverse translated to and from German. Questionnaires included only a study code and no other identifiable information and after completion, were only viewed by researchers not working in the practices.

### ***Treatment arm recruitment***

Having already indicated their WTP for the product, those that completed a questionnaire were screened by their dentist against the inclusion and exclusion criteria for entering the treatment arm of the study. If the patient met the criteria, the patient was offered actual treatment with the intervention for which they would have to pay. The actual price was set individually by each practice in the UK with the German practices agreeing a set fee between them. The dentist informed the participant of the price of the treatment and asked them to consider whether they would wish to receive it. Participants accepting then continued on to have a full course of treatments and paid for this. Dentists recorded acceptance and refusal alongside the price by patients' study codes. The patient pathway through the study is outlined in Figure 1.

### ***Analysis***

Validation consisted of performing rationality and consistency tests on the whole sample. Prior to data entry, German data were converted from Euros to Pounds Sterling (£) at a conversion rate of Euro = £0.70532, the rate at the time of the study.<sup>16</sup>

Analysis was undertaken using Stata.<sup>17</sup> In the absence of any specific questions relating to zero responses, those that marked a response of zero on the questionnaire were treated as true zeros and those that did not respond to the question in any way were treated as protest zeros and were excluded from the analysis.<sup>18</sup> WTP data were analysed using Ordinary Least Squares linear regression (the very low proportion of true zeros made any alternative methods unnecessary).

Comparisons of stated (questionnaire) and revealed (real payment) WTP were made by classifying each participant according to how they would have been predicted to behave using their stated WTP combined with how they actually behaved. The characteristics of those behaving irrationally (given their stated WTP) were then explored using logistic regression models.

### ***Regulatory Approvals***

As the study involved the use of a novel treatment for patients, which at the time did not have marketing authorisation in Europe, the study was classed as a Phase IV Clinical Trial and as such was approved by the UK Medicine and Healthcare Regulatory Authority (MHRA) as well as the German Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM). The study also gained ethical approval from the NHS National Research Ethics Service with the Southampton and South West Hampshire Research Ethics Committee A reviewing the study (approval number 08/H0502/122).

### **Results**

Across all 9 practices, 112 participants completed questionnaires. There were 7 participants who did not respond to the WTP question and were therefore classed as “protest” zeros. The 7 protest zero respondents were excluded from the analysis and so the WTP results have a total sample of 105. One UK practice only had protest zero responses and so this practice was excluded totally. Of the remaining 105, 97 met the criteria for the treatment arm and were therefore offered treatment and therefore this is the sample size for the revealed versus stated preference analyses.

Demographic and dental history data are presented in Table 1. In terms of usual payment for dental treatment, none of the UK group had comprehensive dental insurance compared with 97% of the German group. Responses to income questions varied by country, with 11% of UK participants not responding but 84% of German participants not providing an answer to this question.

WTP data and actual prices charged by each practice are shown in Table 2. There was a large variance in WTP within each practice, reflecting the spread of individual preferences and

potentially, in practices with more than one dentist, a variation in the approach of the dentist. However, there were also large differences between practices in both countries. Comparing UK and German results showed that one-off fee figures were broadly similar in both countries.

A linear regression model is reported in Table 3 ( $n=88$ ,  $R^2=0.167$ ) looking at factors influencing WTP values. Only 88 cases had no missing data in all of the variables included in the model and so only these could be included in this particular model rather than the full sample of 97. Insurance coverage was excluded as this was almost exactly collinear with nationality and income was excluded given the high non-response rate. Although a further 11 cases out of 88 were missing values for “perceived risk”, this variable was deemed to be important and so it was included in two proxy ways. Firstly, a variable of “self-perceived at high risk of caries” was included with those stating they felt at low risk and those with missing data treated as not perceived at high risk. Secondly, a variable of “risk status missing” was also included to see if this group was systematically different from those that had stated risk either to be high or low. The only variable that had a significant effect on WTP was participants who did not answer the perceived risk of caries question who had higher values than those who provided any answer. Undertaking a stepwise regression and removing non-significant variables from the model did not reveal any further significant variables.

Data relating to the comparison of revealed versus stated preference are presented in Tables 4 and 5. For the purposes of this paper, respondents are classified into rational and irrational behaviour groups based on whether their behaviour was predicted by their WTP i.e. those who gave a stated WTP higher than the price and went on to buy the product behaved “rationally” and those who either gave a stated WTP higher than the price and refused to buy or those who gave a stated WTP lower than the price but bought the product would have behaved “irrationally”. There may have been good reasons for “irrational” behaviour (and this is explored further in the discussion) but the terms are used here solely as a descriptor based on expected behaviour from stated WTP. Overall, 63% behaved as expected based on WTP values, but 18% refused when expected to accept and 20% accepted when expected to refuse ( $n=61$ , 17 and 19 respectively). Table 6 shows the mean difference between stated

WTP and the differences were higher in the irrational groups than the rational groups, particularly in the group where acceptance was expected but the patient refused.

Further econometric modelling, not reported in detail here, but including a logistic model using any irrational behaviour as the dependent variable and a further multinomial logistic model with irrational behaviour split into both “refused when expected to accept” and “accepted when expected to refuse” as the two dependent variables showed that only the WTP amount itself was a statistically significant predictor of irrational behaviour, with those with high WTP more likely to refuse when expected to accept and those with a lower WTP more likely to accept when expected to refuse.

## **Discussion**

The primary aim of this study was to elicit WTP values for dental prevention and study the factors affecting these. The research was conducted in primary dental care and related to a dental intervention where a treatment was offered at a real cost. The findings suggest that there is a tangible valuation of prevention for caries but that, in this small sample, this varies widely and unpredictably. In terms of the secondary aim, stated WTP predicated behaviour in the majority of cases, but there were a substantial number of cases where behaviour suggested WTP was over- or under-estimating value.

### *Limitations of the study*

Recruiting on a fully consecutive basis was challenging in a live field environment and the overall sample size was small with recruitment levels especially low in some sub-groups. These types of problems have been reported in other studies in primary care dental research<sup>19</sup> and so were not unexpected. Nonetheless, the overall results reported and especially those looking at sub-groups, should therefore be interpreted with caution. Despite these challenges, the advantages of being able to investigate the primary and especially the secondary aim in a live field environment are very considerable and is relatively novel in dentistry. It will be necessary to confirm the findings in larger studies but this study is an important initial step in a longer process has contributed to the future questions that need answering as well as the design of any further studies.

The sample itself was of a relatively unusual composition with participants being mostly female, and of different age groups between countries. In addition, in the UK, an entirely privately paying sample is unusual with NHS subsidised treatment being more common. It is important to bear in mind the generalisability of the results to any particular population, given these aspects of the sample.

Finally, weighting for different income levels in order to overcome any link with ability to pay would have been ideal but with the low response rate to income questions in Germany in particular, this was not considered feasible in this case.

### *Key findings related to valuations*

Bearing the limitations in mind, it is clear that in the sample there was a demonstrable value and demand for the preventive intervention. There was also a large variance across the sample and sub-samples by practice and country. This will partly be related to the relatively small sample sizes but even taking this into consideration, the variance is larger than in other comparable studies.<sup>20-22</sup> The econometric modelling suggests that this variance is difficult to explain using the variables studied.

The reasons behind this may be genuine differences in how people value prevention. However, valuing an abstract concept such as prevention could be difficult conceptually, meaning that actually the variance may relate to understanding of the task. Even if risk reductions are explained, as was the case here, patients are valuing something that has not happened and still may not, even with the intervention.

### *Questions for policy makers*

The wide variance of valuations found in this sample make decisions about resource allocation difficult and pose further questions. For example, should those with the lowest valuations influence policy makers to allocate less money to prevention? Should policy makers allow those with high valuations to make their own arrangements to provide prevention (i.e. privately) or would this introduce equity issues? Should policy makers be directing resources towards education with the aim of changing the valuations of those who

value prevention less? Further work building on the findings here would help to answer these questions, but it is helpful to raise these challenges for wider debate now.

### *Implications for dentists*

For dentists, the results indicate that no assumptions should be made about what patients will demand in terms of prevention as demographic and dental history indicators do not tend to predict valuations. This is a real clinical challenge in terms of engaging the patient in the process of prevention. It also may mean that the conversation with the dentist is likely to be critical in the decisions to adopt preventive treatments and there were stark variations between the English practices in terms of those opting to have the treatment. Data pertaining to whether dentists would have predicted uptake of the product might be a useful addition in the future as this has been shown to be an important aspect of decision making.<sup>23</sup>

### *Key findings relating to validity of WTP*

The secondary aim concerned the validity of WTP as compared to revealed preference in terms of an actual payment. If the hypothesis was that everyone would behave “rationally” in accepting or refusing to pay for the varnish based on their stated WTP being higher or lower than the price, then this clearly did not hold in this sample with some participants accepting when a refusal was expected and some participants refusing when an acceptance was expected.

One of these apparently irrational behaviours, where the coating was accepted when WTP would predict a refusal is perhaps a surprising result given that many critics of WTP expect WTP to overestimate value due to its hypothetical nature.<sup>24</sup> Conversely, in some cases there was evidence that WTP did overestimate true value but as this was only found in 18% of cases, there is no evidence here that WTP systematically overestimates revealed preference with 63% of people behaving in an apparently rational manner and a further 20% where WTP underestimated true preference. This finding that WTP does not always overestimate WTP is supported by the findings of one of the only other empirical studies in health<sup>12</sup> where increased WTP was the strongest predictor of a decision to purchase the intervention being

studied. The results of this study suggest that the situation is complex and further robust research is required with larger samples.

### *Reasons for “irrational” behaviour*

The reasons behind the “irrational” behaviour demonstrated are difficult to resolve with the data available. The regression models give limited evidence of predictor factors and the small sample sizes make it difficult to identify correlates across the whole sample. Possible explanations include: firstly, that participants were genuinely behaving irrationally (but this would be contrary to established economic and psychological theory); secondly, that the information that the patient received from the dentist between completing the questionnaire (where they stated their WTP) and making the choice to pay for the treatment altered their valuation; thirdly, that respondents may have under-reported WTP to try and reduce the price to be set for the intervention; fourthly, participants may not have engaged with the stated WTP task and only fully engaged once an actual payment was involved in the decision; finally, the participants may have had a budget constraint, in other words they may be willing to pay but not able to at that particular time. The mean differences between stated WTP and price in the different behaviour groups do give limited support to the case that people may not have fully engaged with the task with those with WTP values further from the price more likely to behave irrationally.

### **Conclusions**

WTP values for a caries preventive intervention had a large and unpredictable variance. In terms of WTP methodology, this study suggests that in comparing hypothetical versus real preferences both under- and over-valuation occurs. The limited sample size means that the results may have limited generalizability but the study has shown the value of using WTP in dentistry.

### **Acknowledgements**

Funding for training of practice staff was provided by Denplan Ltd. and CHX technologies. CHX technologies also provided the Prevora coating to the practices. We would like to thank the patients and staff of the practices involved and also Prof Mike Jones-Lee for his comments on an earlier version of this manuscript.

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	<i>UK (%)</i> <i>n=28</i>	<i>German (%)</i> <i>n=77</i>	<i>Total</i> <i>sample (%)</i> <i>n=105</i>
<b>Gender</b>			
Female	54	70	66
Male	43	30	33
Not stated	4	0	1
<b>Age (years)</b>			
40-50	32	31	31
51-60	29	35	33
61-70	25	12	16
71+	14	16	15
Not stated	0	5	5
<b>Yearly gross household income (UK bands with German bands in parentheses)</b>			
<£15600 (≤£14106)	11	1	3
<£20800 (≤£17633)	4	1	2
<£26000 (≤£21160)	14	6	5
<£31200 (≤£28213)	4	1	6
<£36400 (≤£35266)	14	2	5
<£52000 (≤£42319)	11	0	5
>£52000 (>£42319)	32	2	9
Not stated	11	84	65
<b>Frequency of dental visits</b>			
Once yearly or less	7	17	14
More than once yearly	93	82	85
Not stated	0	1	1
<b>Number of restorations in last 2 years</b>			
None	18	18	18
1-2	61	55	56
3 or more	18	21	20
Not stated	4	6	6
<b>Perceived risk of needing a restoration in next 12 months</b>			
Zero/Very low	46	27	32
Less than 50%	14	31	27
About 50%	18	19	19
More than 50%	7	8	8
No response	14	14	14

**Table 1 Proportions of sample for different demographic and dental factors**

<b>Practice</b>	<b>Prevora Charge (£)</b>	<b>Mean stated WTP (standard deviation) (£)</b>
UK1 (n=19)	188	121.10 (81.5)
UK2 (n=5)	124	64.00 (33.6)
UK3 (n=1)	108	120.00 (n/a)
UK4 (n=3)	144	70.00 (17.3)
<b>UK Mean</b>	<b>160.80</b>	<b>105.36 (72.49)</b>
German 1 (n=20)	70.53 (€100)	102.62 (58.63)
German 2 (n=38)	70.53 (€100)	84.27 (55.02)
German 3 (n=11)	70.53 (€100)	114.13 (64.48)
German 4 (n=8)	70.53 (€100)	82.88 (33.24)
<b>German Mean</b>	<b>N/A</b>	<b>93.16 (55.86)</b>
<b>Total Mean</b>	<b>N/A</b>	<b>96.41 (60.61)</b>

**Table 2 Intervention charges and mean stated WTP by practice**

	<b>Coefficient</b>	<b>Standard Error</b>	<b>t</b>	<b>P&gt;t</b>	<b>95% confidence interval</b>
Frequent dental visitor	27.46	22.69	1.21	0.230	-17.70 - 72.63
Had previous restorations	3.24	21.48	0.15	0.881	-39.53 - 46.00
Takes daily medications	28.04	17.48	1.60	0.113	-6.76 - 62.84
Self-perceives at risk of caries	25.11	19.09	1.32	0.192	-12.89 - 63.12
Risk missing	62.26	23.12	2.69	0.009	16.24 - 108.29
Female	14.31	17.34	0.83	0.412	-20.21 - 48.84
German	14.09	20.02	0.70	0.484	-25.76 - 53.94
Age (in years, continuous)	0.06	0.80	0.07	0.946	-1.54 - 1.66
Has gum recession	23.01	16.72	1.38	0.173	-10.28 - 56.30
<i>Constant</i>	33.18	57.11	0.58	0.563	-80.52 - 146.89

**Table 3 Linear regression model of WTP values**

		<b>Total number</b>	<b>Number accepting intervention</b>	<b>Number refusing intervention</b>
Whole sample (n=97)	WTP>Price	58	41 (rational)	17 (irrational)
	WTP< Price	39	19 (irrational)	20 (rational)
UK sub-sample (n=20)	WTP>Price	7	7 (rational)	0 (irrational)
	WTP< Price	13	8 (irrational)	5 (rational)
German sub-sample (n=77)	WTP>Price	51	34 (rational)	17 (irrational)
	WTP< Price	26	11 (irrational)	15 (rational)

**Table 4 Numbers of participants with WTP above and below price and subsequent behaviour (accepting or refusing intervention) for whole sample and by national sub-sample.**

	<b>Subsequent behaviour</b>	<b>Mean (£)</b>	<b>Standard deviation</b>
WTP>Price	Accepted treatment (rational)	56.63	66.26
	Refused treatment (irrational)	81.76	80.64
WTP< Price	Accepted treatment (irrational)	62.05	43.66
	Refused treatment (rational)	56.65	36.43

**Table 5 Mean difference between stated WTP and price and standard deviation by behaviour group.**

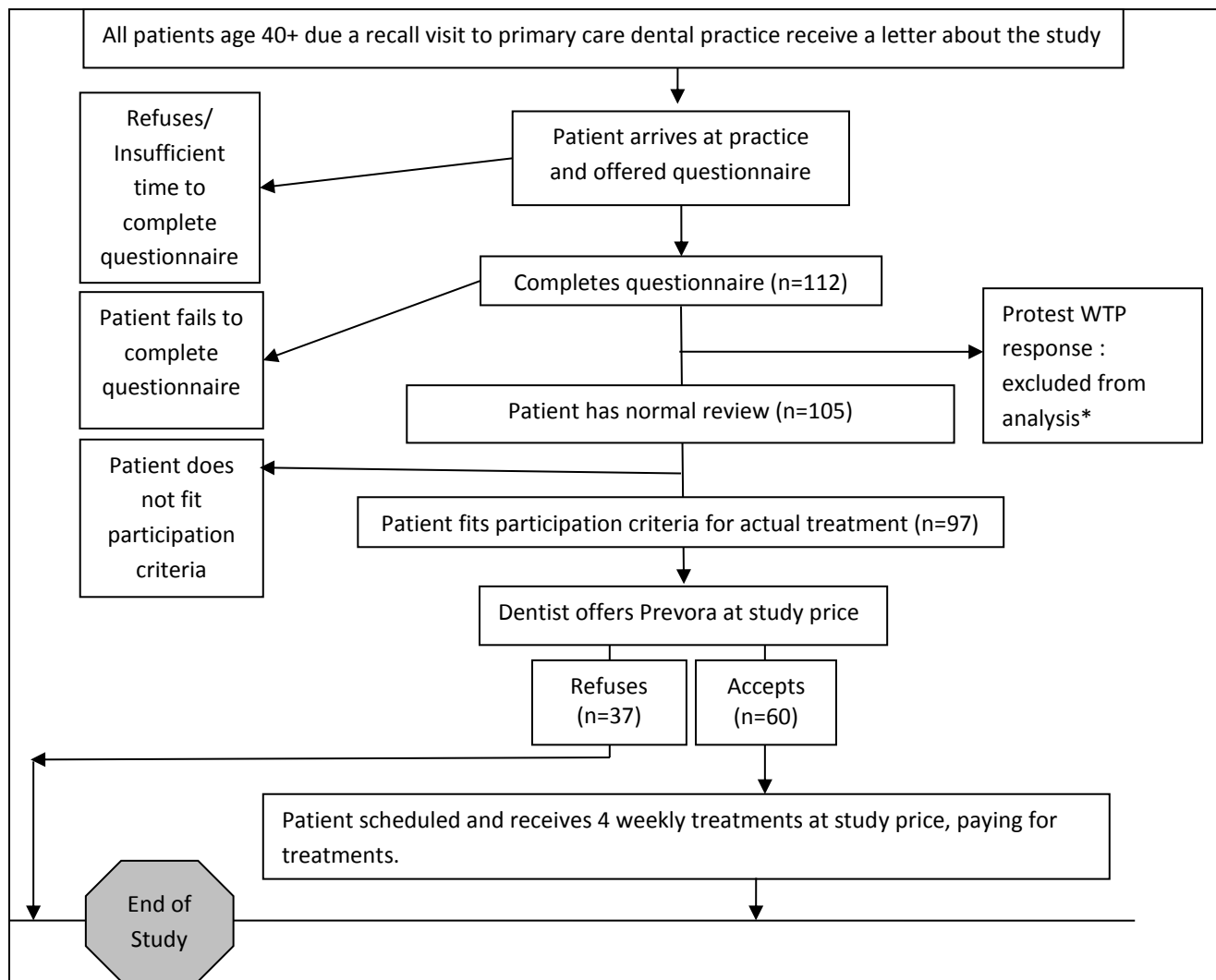


Figure 1 Participant pathway through the study (\* Although patients with protest WTP responses were excluded at the analysis stage, this was not known at the time of the treatment phase of the study and therefore a number of those excluded due to protest responses did proceed to being offered and either accepting or refusing treatment. In order to simplify this figure and the subsequent description of analysis, the excluded participants are excluded from the “n” numbers further on this figure)